

# Joints Properties of One Side Welded of Ship Materials with Variation of Angle Groove

**Yustiasih Purwaningrum<sup>a</sup>, Triyono<sup>b</sup>, Tri Syarifuddin<sup>a</sup>, Isharyadi<sup>a</sup>**

<sup>a</sup>Mechanical Engineering Department, Faculty of Industrial Engineering, Islamic University of Indonesia, Jl. Kaliurang Km. 14,5 Yogyakarta, Indonesia

<sup>b</sup>Mechanical Engineering Department, Sebelas Maret University, Jl. Ir. Sutami 36 A Surakarta, Indonesia  
[yustiasih2003@yahoo.co.nz](mailto:yustiasih2003@yahoo.co.nz) / [yustiasih.purwaningrum@uii.ac.id](mailto:yustiasih.purwaningrum@uii.ac.id)

**Abstract:** Indonesian National Transportation Safety Commission based on data from the period 2003-2008 and The Study for the Maritime Traffic Safety System Development Plan states that 21% of the cause of the accident was the failure of Indonesian ship in the structure of the ship (hull structure). This study aimed to investigate the effect of variations in the angle groove of one side welding. Material used is low carbon steel LR grade A in a thickness 12 mm were welded using GMAW (Gas Metal Arc Welding) with a angle groove 20°, 40° and 60°.

The physical properties examined with an optical microscope and measured mechanical properties with regard to strength, hardness, and toughness using tensile test, hardness test and impact test Charpy Vickers respectively. The test results show the microstructure of the weld, HAZ, and base metals has the same structure is ferrite and perlite. From the results of mechanical tests showed tensile strength is highest in the 40° angle groove is 338.9 MPa. The values of absorbed energy approximately 170 J, which was 58 % of that of weld raw materials.

**Keyword:** One Side Weld, GMAW, angle groove, mechanical properties, physical properties

## 1. Introduction

Ship structure is closely related to the design and production process ship. Almost 90% of the structural failure of the techniques most often fail is the structure of the stress concentration, where 36% of which is the failure of welded joints

[1]. These data indicate the weld joint is the most critical part of including a structure so that researchers and practitioners should pay greater attention on the part of the weld joint.

The Quality of welds is influenced by three factors: the material used, the design and production process. One of the things that are important in the design of welded joints is the angle of groove . Because of the angle of groove will affect the thermal cycles that occur in the welding process.

Reduction of distortion can be done by reducing the heat input of welding with a small gap (0.065 inch) in the plate welding ship body [2].

Orientation of electrode to the workpiece influence the shape of the weld joint and weld penetration path. That influence is greater when compared with the effect of arc voltage and welding speed. Welding orientation depicted in two ways, namely [3] :

- The relationship between the axis of the electrode with the welding direction (angle drive / travel angel)
- The angle between the axis of the electrode to the workpiece surface (angle of work / work angel)

## 2. Materials and Methode

### 2.1. Materials and Welding Processes

The materials studied were low carbon steel LR Gr A in a thickness 12 mm. The specified chemical compositions of test materials are shown in Table 1 .The constant GMAW (Gas

Metal Arc Welding) used for making the test samples including weld current, voltage, welding rate in table 2. The type of current was DCRP (Direct Current Reverse Polarity).

Tabel 1. Chemical Composition of materials

Material	C	Mn	Si	P	S	3.1. Macrostructure
E71T-1	0,2	1,0 – 2,5	0,3 – 0,65	0,03	0,03	Table 3.75 shows fotomacro of one side weld of ship materials
LR Gr A	0,21	1,30	0,30	0,035	0,040	for various angle groove.. The microstructures present in joint

The joints of materials used multi run weld (Figure 1) with 7 layer. The variation of angle groove that used were  $20^\circ$ ,  $40^\circ$  and  $60^\circ$ .

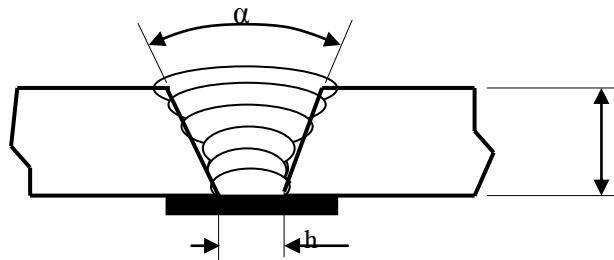


Figure 1. The Shape of Groove

Table 2. Parameter of Welding

No	Filler Rate (mm/s)	Welding rate (mm/s)	rate (Volt)	Voltage (Volt)
1	100.4	3.16	23	
2,3,4,7	100.4	6.25	23	
5,6	100.4	6.25	20	

## 2.2. Joints and Characterization

Microstructure testing carried out using an optical microscope with a magnification of 100 times. Metallography samples prepared in accordance with ASTM E3-01. The microstructure of mild steel was revealed by using  $\text{HNO}_3$  2.5% solution .

The Vickers hardness testing is done by using a load of 200 grf. The Vickers microhardness measurements across the base metal, HAZ (heat affected zone), and the weld metal.

Mechanical strength of weld metals were performed by tensile testing and impact toughness testing. The tensile strength were performed using a servo-hydraulic SHIMADZU universal testing machine. Tensile test specimens were prepared used

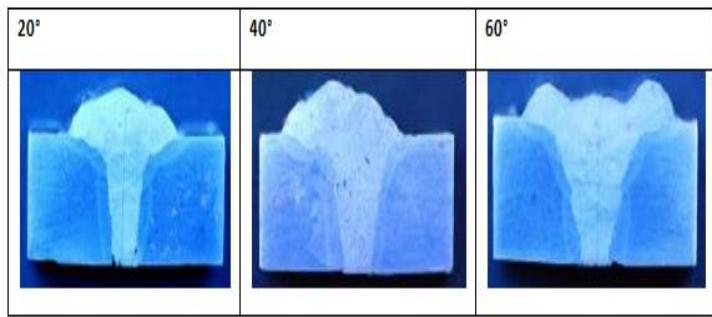
ASTM E8M standard. Impact toughness testing performed using Charpy testing. Standard specimens used were JIS Z 2201

## 3. Results and Discussion

### 3.1. Macrostructure

Table 3.75 shows fotomacro of one side weld of ship materials for various angle groove.. The microstructures present in joint welded can be classified into various zones, i.e. welding zone (WZ), heat affected zone (HAZ) and unaffected base metal (BM) [4]. Fotomacro showed that both metals can be joints properly with all angle groove variations.

Table 3. Fotomacro of Weld Metals



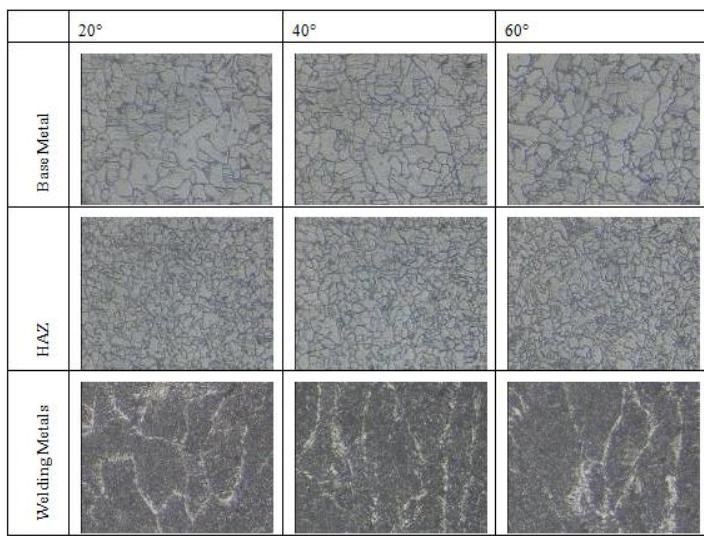
### 3.2. Microstructures

The microstructures of one side weld metals can be seen in table 4. The microstructures of base metal on one side weld were ferrite and pearlite for all variations of the angle groove. Because the base metal is an region that is not affected by heat welding and filler metals.

In HAZ region microstructure is formed similar with base metals region were of ferrite and pearlite. The size of the microstructure on haz area is smaller than the base metal due to the influence of welding heat input.

While the microstructure is formed in the weld area is Accicular ferrite and grain boundary ferrite. Accicular ferrite small sized and has a random orientation so that it will inhibit the growth of crack

Table 4. Microstructures of Weld Metals



### 3.3. Tensile Strength

Transverse strength properties of one side weld joints are presented in Fig. 2. During tensile test, all welded specimens exhibited fracture at base metals. The results of tensile tests showed that welded joints with all variations of angle groove has a similar tensile strength than the base metal. The highest tensile strength was attained at angle groove 40°.

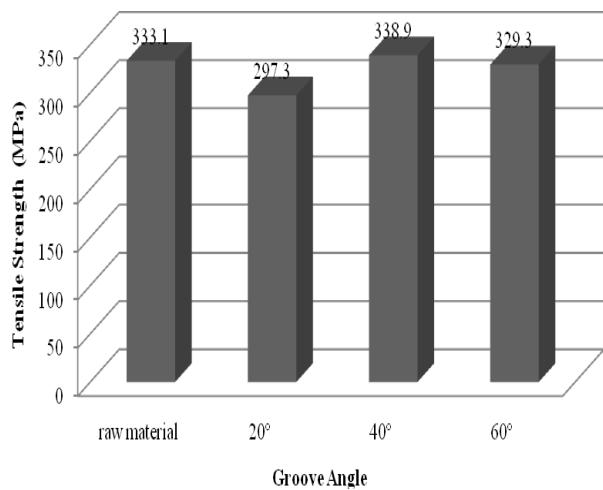


Figure 2. Tensile Strength

### 3.4. Toughness

The toughness of one side welded of ship materials shows on fig 3. All of joint welded with various temperatures have similar absorbed energy. The values of absorbed energy approximately 170 J, which was 58 % of that of weld raw

materials. But these values can still be eligible for the construction of 100 J at room temperature [5].

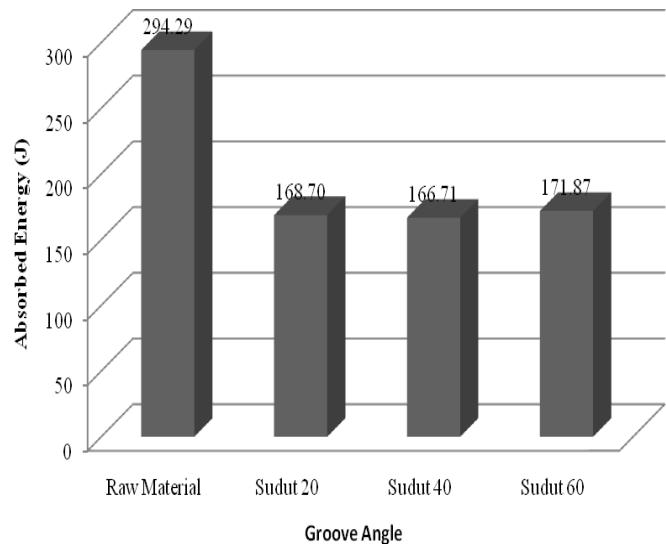


Figure 3. Toughness

### 3.5. Hardness Number

Figure 4 shows the hardness distributions of all welded specimens. For all specimens with variation of methods and temperatures preheat, the hardness decrease at HAZ and the lowest hardness was achieved at base metal. For all filler thickness variations, there was no significant trend difference in the hardness of weld metal, HAZ, and the base metal

It was in accordance with its microstructure that has been discussed previously. In the carbon steel Lr Gr A, due to the acicular ferrite microstructure, the hardness of weld metal was higher than that of base metal and HAZ in which they had the ferrite and pearlite microstructure.

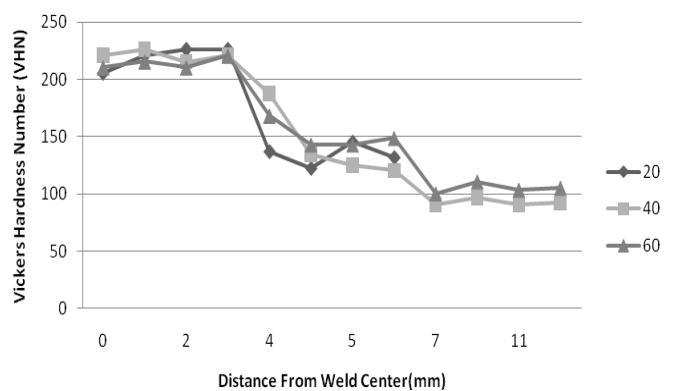


Figure 4. Vickers Hardness Number

#### 4. Conclusion

The main results are summarized as follows:

1. Microstructure of base metal and HAZ carbon steel was ferrite and perlite while that of weld metal was acicular ferrite and grain boundary ferrite
2. In the carbon steel Lr Gr A, weld metal had higher hardness number than the base metal and HAZ due to the microstructure.
3. The values of absorbed energy approximately 170 J, which was 58 % of that of weld raw materials

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